REMARKS

Claims 166-169, 172-174, and 177-180 are pending in the Application

Claims 166-169, 172-174, and 177-180 are rejected.

I. EXAMINER INTERVIEW

On November 16, 2004, the undersigned counsel for Applicant and an inventor of the invention (Dr. Ken Smith) met with the Examiner to discuss the Application and the Final Office Action. Applicant and its counsel appreciate the opportunity to have this discussion and wish to thank the Examiner for the interview.

II. REJECTIONS UNDER 35 U.S.C. § 112, ¶ 1

Examiner has rejected Claims 166-169, 172-174, and 177-180 under 35 U.S.C. § 112, ¶ 1, as failing to comply with the enablement requirement. Specifically, the Examiner stated "[The] claims contain subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention." Second Office Action, at 2. Applicant respectfully traverses this rejection.

Membranes

In the Second Office Action, the Examiner stated that the only reference to a membrane appeared in the Application, on page 48, lines 3-7. During the interview, Applicant directed the Examiner to multiple places within the Application that discussed the claimed membranes. Specifically, these included the following:

(1) Application, at page 35, line 29 – page 36, line 4 (emphasis added):

Arrays containing from 10^3 up to 10^{10} and more SWNT molecules in substantially parallel relationships can be used per se as a nanoporous conductive molecular ***membrane***, e.g., for use in batteries such as the lithium ion battery. This ***membrane*** can also be used (with or without attachment of a photoactive molecule such as cis-

(bisthiacyanato bis (4,4'-dicarboxy-2-2'-bipyridine Ru (II)) to produce a highly efficient photo cell of the type shown in U.S. Patent 5,084,365.

(2) Application, at page 48, lines 3-7 (emphasis added):

> Applications of these carbon fibers include all those currently available for graphite fibers and high strength fibers such as ***membranes*** for batteries and fuel cells; chemical filters; catalysts supports; hydrogen storage (both as an absorbent material and for use in fabricating high pressure vessels); lithium ion batteries; and capacitor ***membranes***.

(3) Application, at page 53, lines 10-27 (emphasis added):

> The anode is characterized by high current, high capacity, low resistance, highly reversible and is nano-engineered from carbon with molecular perfection. The anode is constructed as a ***membrane*** of metallic fullerene nanotubes arrayed as a bed-of-nails, the lithium atoms being stored in the spaces either between the adjacent tubes or down the hollow pore within each tube. Chemical derivatization of the open ends of the tubes will then be optimized to produce the best possible interface with the electrolyte. The derivative is preferably an organic moiety which provides a stable interface where the redox reaction can occur. In general, the organic moiety should be similar in structure to the electrolyte. One preferred derivitizing agent is polyethylene oxide and, in particular, polyethylene oxide oligomers.
>
> The electrochemistry of the nano-engineered nanotube ***membranes*** are used for electrode applications. Important aspects are to derivatize their ends and sides in such a way as to provide an optimal interface for a lithium-ion battery electrolyte. This will result in a battery electrode that is highly accessible to the lithium ions, therefore capable of delivering high power density, and equally important, overcomes the ubiquitous SEI (solid-electrolyte interface) problem that significantly reduces electrode capacity and reversibility.

Applicant notes that in its Amendment Under 37 C.F.R. § 1.111, filed 8 April 2004 ("First 1.111 Amendment), Applicant provided a definition of the term "membrane" that is in complete accord with the manner that term is utilized in the Application, including in the portions recited above. For instance and as noted above, on page 35, Applicant stated "Arrays containing from 10^3 up to 10^{10} and more SWNT molecules in substantially parallel relationships can be used per se as a nanoporous conductive

molecular ***membrane***." Thus the array of single-wall carbon nanotubes which has nanoporosity, is a "thin sheet of natural or synthetic material permeable to substances in solution."[1] *See* First 1.111 Amendment, at 7.

On page 35-37 of the Application, the Applicant discusses "Molecular Arrays of Single-Wall Carbon Nanotubes," including arrays that have nanoporosity that can be used as membranes. In this portion of the Application, the Application reflects at least four ways in which the molecular arrays are formed:

(a) The arrays can be formed by conventional techniques employing "self-assembled monolayers" (SAM) or Langmiur-Blodgett films." Application, at 35, lines 6-29. Such an array is illustrated schematically in Figure 4. Application, at page 35, lines 9-10 & Fig. 4.

(b) The arrays can be formed uses a purified bucky paper as the starting material and employs oxidative treatment and disposing the resulting bucky papers in an electric field. Application, at 36, lines 20-27. In this process, the single-wall carbon nanotubes tend to coalesce due to van der Waals forces to form the molecular array. *Id.*

(c) The arrays can be formed by "combing" purified bucky paper starting material. Application, at page 36, line 28 – page 37, line 16.

(d) The arrays can be formed by utilizing a nanoscale microwell structure. Application, at page 37, lines 18-27.

See also Application, at page 75, lines 22-26, wherein in Example 6, a single-wall carbon nanotubes array is assembled.

The Application, including the portions noted above, contains more than sufficient information to enable one skilled in the pertinent art to make the claimed membrane. Accordingly, the enablement requirement has been satisfied. *See.* M.P.E.P.

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[1] The Examiner states that the configuration of the array recited in the Application at page 35 is not a membrane per Applicant's definition. Applicant traverses Examiner's statement. The array being discussed on page 35 of the Application is expressly identified to be used as a "nanoporous conductive molecular membrane" and likewise falls squarely within the definition of the term "membrane" discussed by Applicant in its First 1.111 Amendment.

2164.01. Thus, Applicants respectfully disagree with Examiner's position that there is no description as to how to make the claimed membranes.

Battery

The Examiner further states that, for Claims 177-180 (directed to a battery comprising a membrane), "it is not understood how a membrane could be present in a battery within applicant's current definition of a membrane." Second Office Action, at 2. In particular, the Examiner suggests Applicant's definition of membrane is such that the description of the membrane when used in a battery (i.e., Application, at pages 52-56) is somehow unclear. Second Office Action, at 2 Moreover, the Examiner appears to contend the array illustrated in Figure 4 cannot be a membrane. *Id.* Applicant respectfully traverses these suggestions.

Once again, Applicant points out that Applicant's definition of membrane is consistent to how that term is used in the Application. In the Application, Applicant noted the arrays made by the processes of the Application could be used in batteries, such as lithium ion secondary batteries. Application, at page 52, lines 19-20. In such batteries, the anode material could include the molecular array, which array would provide "a structural stable microporosity for the intercalation of lithium ions." *Id.*, at page 52, lines 26-27. This squarely falls within the definition of a membrane. This is particularly so given that Applicant specifically refers to this porous array of single-wall carbon nanotubes in the battery as a membrane. *See* Application, at page 53, lines 12-14 & 21-22.

Furthermore, Examiner's apparent suggestion that Figure 4 cannot be a membrane is mistaken. Figure 4 is a schematic representation of a portion of an homogeneous SWNT molecular array according to the present invention. Application, at page 6, lines 27-28 & page 35, line 9. For arrays as illustrated in Figure 4 that contain 10^3 to 10^{10} or more single-wall carbon nanotube molecules in substantially parallel relationship, these are "nanoporous conductive molecular membranes." Application, at page 35, line 29 – page 36, line 1. Thus, Figure 4 can be a membrane. And, as noted, such membrane can

be utilized in a batteries, such as lithium ion batteries. Application, at page 36, line 1; *see also* Application, at page 52, line 19 – page 56, line 11.

Accordingly, the Application is enabling both to form the claimed membrane and for batteries that comprise such membrane. Applicants thus respectfully request the Examiner withdraw his rejections of Claims 166-169, 172-174, and 177-180 under 35 U.S.C. § 112, ¶ 1.

III. OBJECTIONS TO THE DRAWINGS

Examiner has objected to the Application on the grounds that the drawings must show every feature of the invention specified in the claims. Second Office Action, at 3. While Applicant does not agree this is an accurate statement of the drawing requirements for patent applications, even under this standard, the drawings of the Application comply. Accordingly, Applicant traverses the rejections.

As discussed above, Figure 4 is a schematic representation of a portion of an homogeneous SWNT molecular array according to the present invention. Application, at page 6, lines 27-28 & page 35, line 9. And, for arrays as illustrated in Figure 4 that contain 10^3 to 10^{10} or more single-wall carbon nanotube molecules in substantially parallel relationship, these are "nanoporous conductive molecular membranes." Application, at page 35, line 29 – page 36, line 1. Thus, Figure 4 can be a membrane. A review of Figure 4 does show single-wall carbon nanotubes in substantially parallel relationship. The density of the single-wall carbon nanotubes was reduced so that the carbon nanotubes in Figure 4 could be illustrated. Nonetheless, this reflects a membrane as specified in the Claims.

Figure 14 illustrates "an anode for a lithium ion battery according to the present invention." Application, at page 7, lines 15-16; *see also* Application, at page 56, lines 5-11. The substantially parallel single-wall carbon nanotubes in Figure 14 illustrate the membrane in the battery anode.

Fig. 15B is a high-magnification image of one bundle of multiple single-wall carbon nanotubes that are all roughly parallel to each other. Application, at page 7, lines 19-20 & page 71, lines 10-15. In this figure, the single-well carbon nanotubes all have a diameter of about 1 nm, with similar spacing between adjacent single-wall carbon nanotubes; the single-wall carbon nanotubes further adhere to one another by van der Waals forces. Application, at page 71, lines 10-15. Thus, these images reflect the assembly of single-wall carbon nanotubes in a substantially parallel relationship.

Accordingly, the figures in the Application do reflect the features of the claims. Accordingly, Applicants respectfully request the Examiner withdraw his objections to the drawings.

IV. <u>CONCLUSION</u>

As a result of the foregoing, it is asserted by Applicant that the Claims in the Application are now in a condition for allowance, and respectfully request allowance of such Claims.

Applicant respectfully requests that the Examiner call Applicant's attorney at the below listed number if the Examiner believes that such a discussion would be helpful in resolving any remaining problems.

Respectfully submitted,

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